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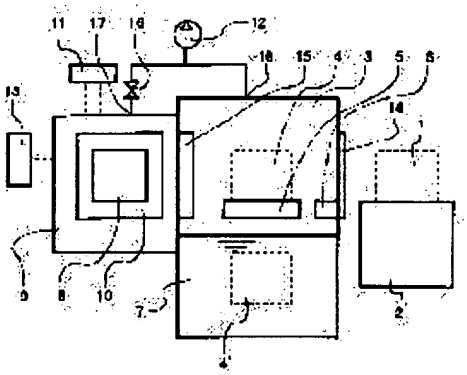
(54) VACUUM CARBURIZATION METHOD AND APPARATUS THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an inexpensive vacuum carburization treatment method which solves the trouble by the excess of a surface carbon concn. including corner parts, allows the treatment under broad carburization pressures and obviates the generation of soot and an apparatus therefor.
SOLUTION: Gaseous ethylene or a gaseous mixture composed of the gaseous ethylene and gaseous acetylene is used as a carburizing gas. The supply rate of this carburizing gas is periodically or impulsively changed from a high flow rate level to a low flow rate level and further to the high flow rate level. The pressure of a carburization chamber 10 at the time of the high level is regulated to a range of 1 to 10 kPa, the flow rate level ratio of the low flow rate level to the high flow rate level to 0 to 50% and the time ratio to 50 to 3,000%. Further, the regulation of the pressure in the carburization chamber is executed by regulating a valve or movable orifice mechanism 16 disposed between an evacuation device 12 and a discharge port 17 of the carburization chamber.



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CLAIMS

[Claim(s)]
[Claim 1] The vacuum carburization approach characterized by to make the amount of supply of this carburization gas change from high flow rate level repeatedly from quantity flow rate level further to low flow rate level once at least to low flow rate level, and to make the pressure of the carburization room at the time of the high flow rate level of said carburization gas into the range of 1-10kPa in vacuum carburization processing, using the mixed gas of ethylene gas or ethylene gas, and acetylene gas as carburization gas.
[Claim 2] Flow rate change of said carburization gas is the vacuum carburization approach [claim 3] according to claim 1 characterized by trying to change periodically. flow rate change of said carburization gas is a pulse-like -- the vacuum carburization approach [claim 4] according to claim 1 or 2 characterized by things The vacuum carburization approach according to claim 1, 2, or 3 characterized by for the flow rate level ratio of low flow rate level to the high flow rate level of carburization gas being 0 - 50%, and the time amount ratio of low flow rate level to high flow rate level being 50 - 3,000% to said carburization room.
[Claim 5] The vacuum carburization approach according to claim 1 to 4 characterized by carrying out by adjusting the bulb or the movable orifice device which adjustment of the pressure of the carburization interior of a room was prepared between the exhaust ports of evacuation equipment and a carburization room.
[Claim 6] In the vacuum carburization equipment which has the carburization room possessing heating apparatus, the evacuation equipment which exhausts this carburization interior of a room, the equipment which supplies carburization gas to this carburization interior of a room, and the cooling room equipped with the oil tank for hardening In order to establish the control system to which carburization gas supply volume is once changed on low flow rate level from high flow rate level from quantity flow rate level at least at a low flow rate level pan and to adjust the pressure of the carburization interior of a room Vacuum carburization equipment characterized by establishing a bulb or a movable orifice device between the exhaust port of a carburization room, and evacuation equipment.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the vacuum carburization art and equipment of a ferrous material.
[0002]
[Description of the Prior Art] Gas carburizing, vacuum carburization, plasma carburization, etc. are carried out to the carburization of a ferrous material from the former. gas carburizing -- the present condition -- although carried out widely, there are troubles, like grain boundary oxidation of the danger of being based on combustible gas, and a processing article front face, and the formation of a short cycle by high temperature carburizing are difficult. Moreover, cost is high and plasma carburization is limited to special carburization. In vacuum carburization, there is the approach of processing by the pressure of 10-70kPa by 900-1100 degrees C, using saturated hydrocarbon (methane, a liquefied petroleum gas, butane) as carburization gas.
[0003] Furthermore, as a carburization art using acetylene, in JP,8-325701,A, the pressure of a vacuum carburization processing room is set to 1 or less kPa, a fixed time amount halt of a sink and its blasting fumes is carried out for fixed time amount acetylene gas, and carbon is diffused inside a processing article.
[0004]
[Problem(s) to be Solved by the Invention] Since [that temperature is the same] the carbon concentration in a furnace becomes high as compared with gas carburizing in the case of this vacuum carburization, and a carbon concentration gradient with the interior becomes large but, it has the advantage that carburization time amount can be shortened. However, in vacuum carburization, especially, since a corner section front face had little front face and area which carbon diffuses inside compared with the flat-surface section, carbon concentration became high, and its retained austenite increased, or it had the problem that reticulated carbide became is easy to be generated. When there was too much this retained austenite or reticulated carbide was generated, there was a problem of reducing the quality of a carburization product greatly. Moreover, when 1kPa was exceeded with acetylene and 10kPa(s) were exceeded with ethylene, respectively, soot was generated, and there was a problem that a control range was narrow.
[0005] The purpose of this invention is offering the approach and equipment which solve the fault by the excess of surface carbon concentration also including the corner section in a vacuum carburization art in view of this trouble, and processing by the broad carburization pressure is possible, and generating of soot does not have, either, and are carburized cheaply.
[0006]
[Means for Solving the Problem] In this invention, the mixed gas of ethylene gas or ethylene gas, and acetylene gas is used as carburization gas in vacuum carburization processing. At least the amount of supply of this carburization gas from quantity flow rate level further to low flow rate level once from high flow rate level to low flow rate level The above-mentioned technical problem was solved by offering the vacuum carburization approach characterized by making it change repeatedly and making the pressure of the carburization room at the time of the high flow rate level of said carburization gas into the range of 1-10kPa.
[0007] By using the mixed gas of ethylene gas or ethylene gas, and acetylene gas for carburization gas, and performing vacuum carburization, it decomposes efficiently on a steel front face, and ethylene and acetylene supply the carbon of the source of carburization. Generation of the reticulated carbide by high-concentration-izing of the carbon of the corner section can be especially controlled by making the

pressure of a carburization room into the range of 1-10kPa, making convention time amount sink carbon the capacity of the convention to a carburization term permeate a front face, convention-time-amount-stopping, or decreasing carburization gas in a diffusion term, and performing pulse carburization which repeats diffusing carbon inside.

[0008] While this is maintaining carburization gas supply at the low and supply of a carbon source is controlled, surface carbon is diffused inside a work piece by thermal diffusion. Again active carburization is repeated by returning supply of carburization gas to high level. Thus, since diffusion of the carbon of the surface section becomes easy to advance by changing the amount of supply of carburization gas between a high level and a low, and repeating this, carburization processing without a surface abnormality layer can be performed. Moreover, since the flow of carburization gas, such as a thin hole, becomes good, the carburization of the narrow space section also becomes homogeneity.

[0009] Since the source of carburization was not superfluously supplied in this carburization art, while being able to control the consumption of carburization gas, generating of the soot of the carburization interior of a room could be suppressed, and it was referred to as 1-10kPa whose pressure of a carburization room is the range larger than before. In addition, in this approach, carburization becomes inadequate in 1 or less kPa, and generating of soot becomes large by 10kPa **.

[0010] Although flow rate change of carburization gas was made into the high flow rate, the low flow rate, the high flow rate, and the low flow rate, it is effective to repeat this according to a carburization situation. Then, flow rate change of carburization gas was made to change periodically in claim 2.

[0011] Moreover, the shape of a pulse tends to control flow rate change of carburization gas like claim 3.

[0012] If there is little flow rate change of distributed gas, and if the time amount at the time of a low flow rate is too short, diffusion inside the carbon at the time of a low flow rate will not be promoted. Then, in claim 4, it is good to make the flow rate level ratio of low flow rate level to the high flow rate level of carburization gas into 0 - 50%, and to make the time amount ratio of low flow rate level to high flow rate level into 50 - 3,000%.

[0013] the configuration and the required surface organization of the corner section -- a proper period and pulse conditions (a flow rate and time amount) -- it is required. For that, control of the amount of supply of carburization gas and the pressure of the carburization interior of a room is important. It is larger for change for control of the pressure of the carburization interior of a room to control [rather than] the amount of exhaust gases by the side of discharge to change of the amount of supply of carburization gas. Then, in claim 5, we decided to carry out by adjusting the bulb or the movable orifice device which adjustment of the pressure of the carburization interior of a room was prepared between evacuation equipment and the exhaust port of a carburization room. In addition, compared with entrance-side control, a carburization quantity of gas flow can be lessened by controlling a flow rate by the exhaust side.

[0014] The carburization room which possesses heating apparatus like claim 6 in operation of this vacuum carburization approach, In the vacuum carburization equipment which has the evacuation equipment which exhausts this carburization interior of a room, the equipment which supplies carburization gas to this carburization interior of a room, and the cooling room equipped with the oil tank for hardening In order to establish the control system to which carburization gas supply volume is once changed on low flow rate level from high flow rate level from quantity flow rate level at least at a low flow rate level pan and to adjust the pressure of the carburization interior of a room The vacuum carburization equipment which established the bulb or the movable orifice device between the exhaust port of a carburization room and evacuation equipment can perform.

[0015]

[Embodiment of the Invention] The gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 is the whole vacuum carburization equipment schematic diagram showing the gestalt of operation of this invention. As shown in drawing 1 , this vacuum carburization furnace consists of a carburization room 10 possessing heating apparatus, a cooling room 3 connected to this carburization room, and a transport device 2 for product in-and-out.

[0016] The heating element which is not illustrated for carrying out heating at high temperature of the work piece 8 is attached in the carburization room 10, and the heat insulation box 9 for incubation is attached in it. Moreover, it has the temperature controller 13 which controls the gas supply board 11 which is made to be supplied into the carburization room 10 from the feed hopper which does not illustrate the mixed gas of ethylene gas or ethylene gas, and acetylene gas, and controls this carburization gas supply volume, and a heating element. These configurations are the same as that of conventional vacuum carburization equipment almost, and the exhaust port 17 of a carburization room is connected to evacuation equipment 12 in the further conventional thing. However, in this equipment, the bulb 16 for

adjusting the pressure of the carburization interior of a room between the exhaust port 17 of a carburization room and evacuation equipment 12 especially is connected. Although this bulb 16 is the example between evacuation equipment 12 and an exhaust port 17 attached in the main exhaust air bulb which is not illustrated and the serial, it may be attached in juxtaposition. Furthermore also between evacuation equipment 12 and the exhaust port 18 of a cooling room 3, the exhaust air bulb which is not illustrated attaches, and it is **********. Moreover, evacuation equipment 12 may be formed in a cooling room 3 and the carburization room 10, respectively.

[0017] Therefore the cooling room 3 connected to the carburization room 10 is constituted by the quenching-oil tub 7, and the quenching elevator 5 and the transport device 6 in a furnace, and closing motion of a carburization room is enabled for it by the divisional title 15. Furthermore, closing motion of a cooling room 3 is enabled by the front door 14. It is made for doors 14 and 15 to have each ** sealed. Moreover, the exhaust port 18 of a cooling room 3 is connected between evacuation equipment 12 and a bulb 16. The conveyance table 2 for taking a work piece before the front door 14 of a cooling room 3 is arranged. In addition, signs 1 and 4 and 4'8 show the work piece in each equipment.

[0018] Next, the carburization approach of this invention is explained. The following processings are performed one by one using the equipment of this invention of drawing 1 .

(1) Consider a bulb 16 as full open mostly with evacuation equipment 12 first, and carry out evacuation of the carburization room 10 and the cooling room 3 in the condition which opened the exhaust air bulb of the carburization room 10 which is not illustrated further, and the exhaust air bulb of a cooling room 3, i.e., the condition of having made the carburization room 10 and the cooling room 3 opening for free passage, to 0.05 or less kPas.

(2) Carry out a temperature up to carburization temperature, exhausting the carburization room 10 after reaching a predetermined pressure.

(3) Open the front door 14 of a cooling room 3 wide, carry in a work piece 4 for a work piece 1 on the quenching elevator 5 on the conveyance table 2, and shut a front door 14.

(4) Carry out evacuation of the cooling room 3 to 0.05 or less kPas with evacuation equipment 12.

(5) Open a divisional title 15 wide after reaching a predetermined pressure, convey the processing article 4 in the carburization room 10 from a cooling room 3, and shut a divisional title.

(6) Carry out vacuum heating of the carburization room 10, heat and carry out soak of the work piece 4 to predetermined temperature (850-1100 degrees C).

(7) Supply carburization gas in the carburization room 10 from carburization gas supply opening by the blasting-fumes supply board 11. By furthermore adjusting a bulb 16, it adjusts so that the pressure of the carburization interior of a room [gas / carburization] at the time of high flow rate level may turn into a predetermined pressure of the range of 1-10kPa.

[0019] Carburization gas is set by the predetermined flow rate (high flow rate level) at a sink and diffusion term, carburization gas is stopped or decreased (low flow rate level), and this is repeated at a carburization term. The flow rate level ratio of low flow rate level to high flow rate level is made into 0 - 50%. This is periodically repeated between under elevated-temperature maintenance by the time amount (the time amount ratio of diffusion/carburization 50 - 3,000%) set up in advance.

(8) Carburization (henceforth pulse carburization) of the shape of this pulse is completed, and after elevated-temperature holding-time termination, to quenching temperature, lower a carburization room and carry out soak heating further if needed.

[0020] In addition, although the pressure of the carburization interior of a room changes with the amounts of carburization gas, since the capacity of evacuation equipment is large enough compared with the amount of supply of carburization gas, it is controlled by the predetermined pressure by the bulb 16. What is necessary is just to adjust according to the time of high flow rate level, although it adjusts in the range of 1-10kPa at the time of the high flow rate level of carburization gas, and bulb adjustment may adjust also at the time of low flow rate level since the pressure not more than it is sufficient at the time of low flow rate level. When a flow rate level ratio is 0, it is set to 0.05 or less kPas at the time of low flow rate level.

[0021] (9) After the temperature of the carburization room 10 falls to quenching temperature, open a divisional title 15 wide, after moving a work piece 4 to a cooling room 3 and taking out on an elevator 5 by the internal transport device 6, shut a divisional title 15, drop an elevator 5, into the oil of an oil tank 7, dip work-piece 4' and carry out quenching processing. Nitrogen gas is introduced under into atmospheric pressure at this time.

(10) Raise an elevator 5, after predetermined carries out time amount maintenance in an oil, and carry out an oil thrower.

(11) Make a cooling room 3 into atmospheric pressure.
(12) After opening a front door 14 wide and taking out a work piece 4 on the conveyance table 2 outside a furnace, vacuum carburization processing of 1 cycle is completed by closing a front door 14 by carrying out evacuation of the (13) cooling room 3 to 0.05 or less kPas with evacuation equipment 12.
[0022]
[Example] (Example 1) The example of the vacuum carburization using this equipment shown in drawing 1 below is explained. Ethylene gas was used for carburization gas in the example 1. After the quality of the material conveys SCM415 and the processing article of the with an outer-diameter die length [10mm die length of 20mm] round bar in a carburization room and heats the temperature of the carburization interior of a room at 930 degrees C, ethylene gas is supplied for 1 minute by flow rate 1 Lit/min. It carburizes carrying out exhaust air bulb adjustment so that it may be set to carburization internal pressure force 1.3kPa, and ethylene gas is stopped and diffused for 4 minutes after that, and ethylene gas is supplied for 1 minute by carburization internal pressure force 1.3kPa, and ethylene gas is stopped for 4 minutes after that. After cooling to 850 degrees which is quenching temperature after carrying out pulse carburization which repeats this for 1 hour (a total of 12 times) and holding at this temperature for 30 minutes, it transported to the cooling room and oil quenching was carried out.
[0023] When carbon analysis of the processing article which performed this vacuum carburization processing was carried out, the distance from the front face where, as for surface carbon concentration, 0.81% and carbon concentration become 0.3% was set to 0.55mm, and was a proper value. Moreover, carbide reticulated in the organization of the corner section was not seen, and its retained austenite is also normal and it did not have generating of soot, either.
[0024] (Example 2) Next, the example 2 of this invention which used mixed gas (ethylene gas 70% and acetylene gas 30%) for carburization gas is explained. In the example 2, use this equipment shown in drawing 1 R> 1, and the quality of the material conveys SCM415 and the processing article of the with an outer-diameter die length [10mm die length of 20mm] round bar in a carburization room. Carrying out exhaust air bulb adjustment so that it may be set to carburization internal pressure force 2.6kPa, after heating the temperature of the carburization interior of a room at 930 degrees C Carrying out exhaust air bulb adjustment so that mixed gas (ethylene gas 70% and acetylene gas 30%) may be supplied for 1 minute, and may be carburized by flow rate 1 Lit/min and it may be set to carburization internal pressure force 0.13kPa after that After having cooled to 850 quenching temperature after carrying out pulse carburization which reduces mixed gas to flow rate 0.1 Lit/min, carries out sink diffusion for 5 minutes, and repeats this for 1 hour (10 times), and holding at this temperature for 30 minutes, it transported to the cooling room and oil quenching was carried out.
[0025] When carbon analysis of this processing article was carried out, the distance from the front face where, as for surface carbon concentration, 0.84% and carbon concentration become 0.3% was 0.58mm and a proper value. Moreover, carbide reticulated in the organization of the corner section was not seen, and its retained austenite is also normal and it did not have generating of soot.
[0026]
[Effect of the Invention] Since it considered as the pulse carburization which the amount of supply of the mixed gas of ethylene gas or ethylene gas, and acetylene gas was repeated [carburization] to the low flow rate level pan with high flow rate level, and changed it from quantity flow rate level to it once at least according to the approach of this invention, carburization processing without a surface abnormality layer can be performed, and the carburization of the narrow space section also becomes homogeneity. There is no fault by the excess of surface carbon concentration also including especially the corner section. Moreover, since the pressure of the carburization room at the time of the high flow rate level of carburization gas was made into the range of 0.1-10kPa, it became what offers the approach which generating of soot does not have, either and is carburized cheaply.
[0027] Moreover, since the source of carburization is not supplied superfluously but the consumption of carburization gas can be controlled by pulse carburization, the new vacuum carburization equipment which can lower a total running cost can be offered, and it is very useful on industry.
[0028] Moreover, since flow rate change of carburization gas was made to change periodically, it became what has more uniform carburization.
[0029] Moreover, since flow rate change of carburization gas was considered as pulse-like control, conventional vacuum carburization equipment is [that it is easy to carry out control] easily convertible into this equipment.
[0030] Moreover, it became what can do carburization more certainly by making the flow rate level ratio of high flow rate level and low flow rate level into 0 - 50%, and making the time amount ratio of low flow

rate level to high flow rate level into 50 - 3,000%. Since a flow rate is controlled by the exhaust side by adjusting a bulb or a movable orifice device for adjustment of the pressure of the carburization interior of a room, control is easy, and a carburization quantity of gas flow can also be lessened and can reduce the further cost.

[0031] The carburization room possessing heating apparatus, and the evacuation equipment which exhausts the carburization interior of a room, To the conventional vacuum carburization equipment which has the equipment which supplies carburization gas to the carburization interior of a room, and the cooling room equipped with the oil tank for hardening, in addition, the control system which changes carburization gas supply volume from quantity flow rate level to a low flow rate level pan once at least at high flow rate level, In order to adjust the pressure of the carburization interior of a room, by establishing a bulb or a movable orifice device between the exhaust port of a carburization room, and evacuation equipment Pulse carburization could be carried out and it became what offers the vacuum carburization equipment without generating of soot without the fault it is uniform and according to the excess of surface carbon concentration without the above-mentioned surface abnormality layer which lowered cost.

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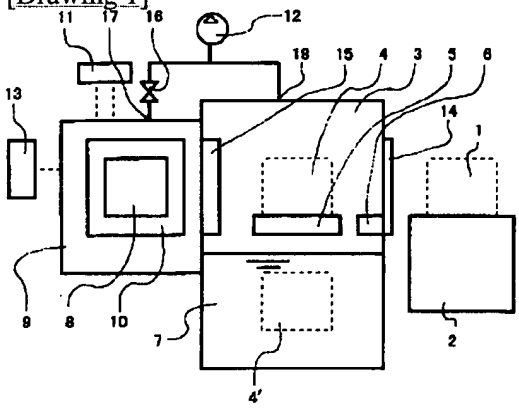
DRAWINGS

[Drawing 1]



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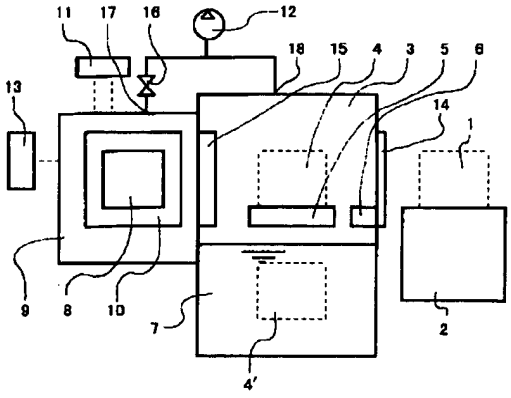
最終頁に続く

(54)【発明の名称】　真空浸炭方法及び装置

(57)【要約】
【課題】　コーナー部も含めた表面炭素濃度過多による不具合を解決し、かつ幅広い浸炭圧力での処理が可能で煤の発生も無い安価な真空浸炭処理方法、装置を提供。
【解決手段】　浸炭ガスとしてエチレンガス又はエチレンガスとアセチレンガスとの混合ガスを用い、浸炭ガスの供給量を高流量レベルから低流量レベルさらに高流量レベルと周期的又はパルス状に変化させ、かつ高流量レベル時の浸炭室１０の圧力を１～１０ｋＰａの範囲にし、高流量レベルに対する低流量レベルの流量レベル比を０～５０%、時間比を５０～３，０００%とし、さらに浸炭室内の圧力の調整を、真空排気装置１２と浸炭室の排気口１７間に設けられたバルブ又は可動オリフィス機構１６を調整することにより行う。



【特許請求の範囲】
【請求項１】　真空浸炭処理において、浸炭ガスとしてエチレンガス又はエチレンガスとアセチレンガスの混合ガスを用い、該浸炭ガスの供給量を少なくとも一度高流量レベルから低流量レベルへ、さらに高流量レベルから低流量レベルへと、繰り返して変化させ、かつ前記浸炭ガスの高流量レベル時の浸炭室の圧力が１～１０ｋＰａの範囲にされていることを特徴とする真空浸炭方法。
【請求項２】　前記浸炭ガスの流量変化は周期的に変化するようにされていることを特徴とする請求項１記載の真空浸炭方法
【請求項３】　前記浸炭ガスの流量変化はパルス状であることことを特徴とする請求項１又は２記載の真空浸炭方法
【請求項４】　前記浸炭室へ浸炭ガスの高流量レベルに対する低流量レベルの流量レベル比が０～５０％であり、かつ高流量レベルに対する低流量レベルの時間比が５０～３，０００％であることを特徴とする請求項１又は２又は３に記載の真空浸炭方法。
【請求項５】　浸炭室内の圧力の調整を、真空排気装置と浸炭室の排気口間に設けられたバルブ又は可動オリフィス機構を調整することにより行うことを特徴とする請求項１乃至４のいずれか一に記載の真空浸炭方法。
【請求項６】　加熱装置を具備した浸炭室と、該浸炭室内を排気する真空排気装置と、該浸炭室内へ浸炭ガスを供給する装置と、焼入れ用油槽を備えた冷却室とを有する真空浸炭装置において、浸炭ガス供給量を少なくとも一度高流量レベルから低流量レベルさらに高流量レベルから低流量レベルに変化させる制御系を設け、かつ浸炭室内の圧力を調節するために、浸炭室の排気口と真空排気装置との間にバルブ又は可動オリフィス機構を設けたことを特徴とする真空浸炭装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は鉄鋼材料の真空浸炭処理方法及び装置に関する。
【０００２】
【従来の技術】鉄鋼材料の浸炭には従来からガス浸炭、真空浸炭、プラズマ浸炭等が行われている。ガス浸炭は現状広く行われているが、可燃ガスによる危険性、処理品表面の粒界酸化、高温浸炭による短サイクル化が難しい等の問題点がある。またプラズマ浸炭はコストが高く特殊浸炭に限定されている。真空浸炭では９００～１１００℃で浸炭ガスとして飽和炭化水素（メタンガス、プロパンガス、ブタン）を用いて１０～７０ｋＰａの圧力で処理する方法がある。
【０００３】さらに、アセチレンを用いた浸炭処理方法として、特開平8-325701号公報では、真空浸炭処理室の圧力を１ｋＰａ以下とし、一定時間アセチレンガスを流し、その後ガスを一定時間停止し処理品内部へ炭素を拡散させている。
【０００４】
【発明が解決しようとする課題】かかる真空浸炭の場合にはガス浸炭と比較すると炉内の炭素濃度が高くなるため、温度が同じでも、内部との炭素濃度勾配が大きくなるため浸炭時間を短縮することができるという利点を有する。しかし、真空浸炭においては、表面、特に、コーナー部表面は平面部と比べ内部へ炭素が拡散する面積が少ないため、炭素濃度が高くなり残留オーステナイトが多くなり、又は網状の炭化物が生成されやすくなるという問題があった。この残留オーステナイトが多すぎたり、網状の炭化物が生成されると浸炭製品の品質を大きく低下させるという問題があった。又、アセチレンでは１ｋＰａ、エチレンでは１０ｋＰａをそれぞれ超えると煤が発生し、制御範囲が狭いという問題があった。
【０００５】本発明の目的はかかる問題点に鑑みて、真空浸炭処理方法において、コーナー部も含めた表面炭素濃度過多による不具合を解決し、かつ幅広い浸炭圧力での処理が可能で煤の発生も無く安価に浸炭する方法及び装置を提供することである。
【０００６】
【課題を解決するための手段】本発明においては、真空浸炭処理において、浸炭ガスとしてエチレンガス又はエチレンガスとアセチレンガスの混合ガスを用い、該浸炭ガスの供給量を少なくとも一度高流量レベルから低流量レベルへ、さらに高流量レベルから低流量レベルへと、繰り返して変化させ、かつ前記浸炭ガスの高流量レベル時の浸炭室の圧力が１～１０ｋＰａの範囲にされていることを特徴とする真空浸炭方法を提供することにより上記課題を解決した。
【０００７】浸炭ガスにエチレンガス又はエチレンガスとアセチレンガスの混合ガスを用いて真空浸炭を行う事により、エチレンやアセチレンは鋼表面で効率的に分解して、浸炭源の炭素を供給する。浸炭室の圧力を１～１０ｋＰａの範囲にして、浸炭期に規定のガス量を規定時間流し炭素を表面に浸透させ、拡散期では浸炭ガスを規定時間停止又は減少させて、炭素を内部へ拡散することを繰り返すパルス浸炭を行うことにより、特にコーナー部の炭素の高濃度化による網状の炭化物の生成を抑制することができる。
【０００８】これは浸炭ガス供給を低レベルに保っている間は、炭素源の供給が抑制されるとともに、表層の炭素は熱拡散によりワークの内部へ拡散する。浸炭ガスの供給を高いレベルに戻すことにより再び活発な浸炭が繰り返される。このように浸炭ガスの供給量を高レベルと低レベルの間で変化させこれを繰り返すことにより、表層部の炭素の拡散が進行しやすくなるので、表面異常層のない浸炭処理ができるのである。また、細い穴部等の浸炭ガスの流れがよくなるので、狭い空間部の浸炭も均一になる。

【０００９】本浸炭処理方法では浸炭源を過剰に供給しないので、浸炭ガスの消費量が抑制できるとともに、浸炭室内の煤の発生を抑えることができ、浸炭室の圧力が従来より広い範囲である１～１０ｋＰａとした。なお、本方法においては、１ｋＰａ以下では浸炭が不十分となり、１０ｋＰａ超では煤の発生が大きくなる。

【００１０】浸炭ガスの流量変化は高流量、低流量、高流量、低流量としたが、浸炭状況によりこれを繰り返すのが効果的である。そこで、請求項２においては、浸炭ガスの流量変化を周期的に変化するようにした。

【００１１】また、請求項３のように、浸炭ガスの流量変化はパルス状が制御しやすい。

【００１２】供給ガスの流量変化が少ないと、又、低流量時の時間が短すぎると低流量時の炭素の内部への拡散が促進されない。そこで請求項４においては、浸炭ガスの高流量レベルに対する低流量レベルの流量レベル比を０～５０％とし、かつ高流量レベルに対する低流量レベルの時間比を５０～３，０００％とするのがよい。

【００１３】コーナー部の形状や必要な表面組織により、適正な周期やパルス条件（流量と時間）必要である。このためには、浸炭ガスの供給量及び浸炭室内の圧力の制御が重要である。浸炭室内の圧力の制御は、浸炭ガスの供給量の変化に対するより、排出側の排出ガス量を制御する方が変化が大きい。そこで、請求項５においては、浸炭室内の圧力の調整を、真空排気装置と浸炭室の排気口との間に設けられたバルブ又は可動オリフィス機構を調整することにより行うこととした。なお、排気側で流量を制御することにより、入口側制御に比べ、浸炭ガス流量を少なくすることができる。

【００１４】かかる真空浸炭方法の実施にあたっては、請求項６のように、加熱装置を具備した浸炭室と、該浸炭室内を排気する真空排気装置と、該浸炭室内へ浸炭ガスを供給する装置と、焼入れ用油槽を備えた冷却室とを有する真空浸炭装置において、浸炭ガス供給量を少なくとも一度高流量レベルから低流量レベルさらに高流量レベルから低流量レベルに変化させる制御系を設け、かつ浸炭室内の圧力を調節するために、浸炭室の排気口と真空排気装置との間にバルブ又は可動オリフィス機構を設けた真空浸炭装置により行うことができる。

【００１５】

【発明の実施の形態】本発明の実施の形態について図面を参照して説明する。図１は本発明の実施の形態を示す真空浸炭装置の全体概要図である。図１に示すように、本真空浸炭炉は加熱装置を具備した浸炭室１０と、該浸炭室に接続された冷却室３と、製品出入用の搬送装置２から構成されている。

【００１６】浸炭室１０には、ワーク８を高温加熱するための図示しない発熱体が取り付けられ、かつ保温のための断熱箱９が取り付けられている。また、エチレンガス又はエチレンガスとアセチレンガスの混合ガスを図示しない供給口から浸炭室１０内へ供給するようにされており、この浸炭ガス供給量を制御するガス供給盤１１と発熱体を制御する温度制御装置１３が備えられている。これらの構成は従来の真空浸炭装置とほぼ同様であり、さらに、従来のものでは浸炭室の排気口１７が真空排気装置１２に接続されている。しかし、本装置においては、特に浸炭室の排気口１７と真空排気装置１２の間に浸炭室内の圧力を調整するためのバルブ１６が接続されている。このバルブ１６は真空排気装置１２と排気口１７の間にある、図示しない主排気バルブと直列に取付けた例であるが、並列に取付けてもよい。さらに真空排気装置１２と冷却室３の排気口１８の間にも、図示しない排気バルブが取付けれれている。又、真空排気装置１２は、冷却室３と浸炭室１０にそれぞれ設けてもよい。

【００１７】浸炭室１０に接続された冷却室３は、焼き入れ油槽７と、焼き入れエレベーター５及び炉内搬送装置６、によって構成され、浸炭室とは中扉１５により開閉可能にされている。さらに、冷却室３は前扉１４によって開閉可能にされている。扉１４、１５はそれぞれの室を密閉できるようにされている。また、冷却室３の排気口１８が真空排気装置１２とバルブ１６との間に接続されている。冷却室３の前扉１４の前にワークを出し入れをするための搬送テーブル２が配置されている。なお、符号１、４、４′８はそれぞれの装置でのワークを示す。

【００１８】次に本発明の浸炭方法について説明する。図１の本発明の装置を用いて以下の処理を順次行う。

(1) まず真空排気装置１２によりバルブ１６をほぼ全開とし、さらに図示しない浸炭室１０の排気バルブ、及び冷却室３の排気バルブ、を開いた状態、即ち浸炭室１０と冷却室３を連通させた状態で、浸炭室１０と冷却室３を０．０５ｋＰａ以下まで真空排気する。

(2) 所定の圧力に達した後、浸炭室１０を排気しながら浸炭温度まで昇温する。

(3) 冷却室３の前扉１４を開放して、ワーク１を搬送テーブル２によって焼き入れエレベータ５上にワーク４を搬入し、前扉１４を閉める。

(4) 冷却室３を真空排気装置１２により０．０５ｋＰａ以下まで真空排気する。

(5) 所定の圧力に達した後中扉１５を開放して、処理品４を冷却室３から浸炭室１０内に搬送し、中扉を閉める。

(6) 浸炭室１０を真空加熱しワーク４を所定温度（８５０～１１００℃）に加熱、均熱する。

(7) その後ガス供給盤１１により浸炭ガスを浸炭ガス供給口から浸炭室１０内に供給する。さらにバルブ１６を調整することにより浸炭ガスが高流量レベル時の浸炭室内の圧力が１～１０ｋＰａの範囲の所定圧力になるように調整する。

【００１９】浸炭期においては浸炭ガスを所定の流量

（高流量レベル）で流し、拡散期において浸炭ガスを停止又は減少（低流量レベル）させ、これを繰り返す。高流量レベルに対する低流量レベルの流量レベル比を０～５０％とされる。これを事前に設定された時間（拡散／浸炭の時間比５０～３，０００％）により高温保持中の間、周期的に繰り返す。

(8) かかるパルス状の浸炭（以下パルス浸炭という）が終了し高温保持時間終了後、焼き入れ温度まで浸炭室を降温し、必要に応じさらに均熱加熱する。

【００２０】なお、浸炭室内の圧力は浸炭ガスの量により変化するが、真空排気装置の能力は浸炭ガスの供給量に比べ十分大きいので、バルブ１６により所定の圧力で制御される。浸炭ガスの高流量レベル時に１～１０ｋＰａの範囲で調整し、低流量レベル時はそれ以下の圧力でよいので、バルブ調整は低流量レベル時も調整してもよいが、高流量レベル時に合わせて調整しておけばよい。流量レベル比が０の場合、低流量レベル時は例えば０．０５ｋＰａ以下となる。

【００２１】(9) 浸炭室１０の温度が焼き入れ温度まで低下した後、中扉１５を開放し、内部搬送装置６によってワーク４を冷却室３に移動し、エレベーター５の上に搬出した後、中扉１５を閉め、エレベーター５を下降させ、油槽７の油中にワーク４′を浸して焼き入れ処理する。このとき窒素ガスを大気圧未満まで導入する。

(10)油中で所定の時間保持した後エレベーター５を上昇させ、油切りする。

(11)冷却室３を大気圧にする。

(12)前扉１４を開放して、ワーク４を炉外の搬送テーブル２に搬出した後、前扉１４を閉じ、そして

(13)冷却室３を真空排気装置１２により０．０５ｋＰａ以下まで真空排気することにより、１サイクルの真空浸炭処理が完了する。

【００２２】

【実施例】（実施例１）次に図１に示す本装置を用いた真空浸炭の実施例を説明する。実施例１では浸炭ガスにエチレンガスを用いた。材質がＳＣＭ４１５、外径２０ｍｍ長さ１０ｍｍの丸棒の処理品を浸炭室に搬送し、浸炭室内の温度を９３０℃に加熱した後、エチレンガスを流量１Ｌｉｔ／ｍｉｎで１分間供給して、浸炭室内圧力１．３ｋＰａになるように排気バルブ調整しながら浸炭し、その後４分間エチレンガスを停止して拡散し、また、浸炭室内圧力１．３ｋＰａでエチレンガスを１分間供給し、その後４分間エチレンガスを停止する。これを１時間（計１２回）繰り返すパルス浸炭をした後、焼き入れ温度である８５０度迄冷却し、この温度で３０分保持した後、冷却室に移送し油冷した。

【００２３】かかる真空浸炭処理を行った処理品の炭素分析をしたところ、表面の炭素濃度は０．８１％、炭素濃度が０．３％になる表面からの距離は０．５５ｍｍとなり適正な値であった。またコーナー部の組織には網状の炭化物は見られず、残留オーステナイトも正常であり、煤の発生も無かった。

【００２４】（実施例２）次に、浸炭ガスにエチレンガス７０％とアセチレンガス３０％との混合ガスを用いた本発明の実施例２について説明する。実施例２では、図１に示す本装置を使用し、材質がＳＣＭ４１５、外径２０ｍｍ長さ１０ｍｍの丸棒の処理品を浸炭室に搬送し、浸炭室内の温度を９３０℃に加熱した後、浸炭室内圧力２．６ｋＰａになるように排気バルブ調整しながら、エチレンガス７０％とアセチレンガス３０％との混合ガスを流量１Ｌｉｔ／ｍｉｎで１分間供給して浸炭し、その後、浸炭室内圧力０．１３ｋＰａになるように排気バルブ調整しながら、混合ガスを流量０．１Ｌｉｔ／ｍｉｎに減じて５分間流し拡散しこれを１時間（１０回）繰り返すパルス浸炭をした後、焼き入れ温度８５０度迄冷却し、この温度で３０分保持した後、冷却室に移送し油冷した。

【００２５】かかる処理品の炭素分析をしたところ、表面の炭素濃度は０．８４％、炭素濃度が０．３％になる表面からの距離は０．５８㎜と適正な値であった。またコーナー部の組織には網状の炭化物は見られず、残留オーステナイトも正常であり、煤の発生が無かった。

【００２６】

【発明の効果】本発明の方法によれば、エチレンガス又はエチレンガスとアセチレンガスの混合ガスの供給量を少なくとも一度高流量レベルから低流量レベルさらに高流量レベルと繰り返し変化させたパルス浸炭としたので、表面異常層のない浸炭処理ができ、狭い空間部の浸炭も均一になる。特にコーナー部も含めた表面炭素濃度過多による不具合がない。また、浸炭ガスの高流量レベル時の浸炭室の圧力を０．１～１０ｋＰａの範囲にしたので、煤の発生も無く安価に浸炭する方法を提供するものとなった。

【００２７】また、パルス浸炭により、浸炭源を過剰に供給せず、浸炭ガスの消費量を抑制できるので、トータルのランニングコストを下げることができる新たな真空浸炭装置を提供でき、産業上非常に有益である。

【００２８】また、浸炭ガスの流量変化を周期的に変化するようにしたので、より浸炭が均一なものとなった。

【００２９】また、浸炭ガスの流量変化をパルス状の制御としたので、制御がしやすく従来の真空浸炭装置を簡単に本装置に改造できる。

【００３０】また、高流量レベルと低流量レベルの流量レベル比を０～５０％とし、かつ高流量レベルに対する低流量レベルの時間比を５０～３，０００％とすることにより、より確実に浸炭ができるものとなった。浸炭室内の圧力の調整を、バルブ又は可動オリフィス機構を調整することにより排気側で流量を制御するので、制御が簡単で、浸炭ガス流量も少なくすることができ、さらなるコストが低減できる。

【００３１】加熱装置を具備した浸炭室と、浸炭室内を排気する真空排気装置と、浸炭室内へ浸炭ガスを供給する装置と、焼入れ用油槽を備えた冷却室とを有する従来の真空浸炭装置に加えて、浸炭ガス供給量を少なくとも一度高流量レベルから低流量レベルさらに高流量レベルに変化させる制御系と、浸炭室内の圧力を調節するために、浸炭室の排気口と真空排気装置との間にバルブ又は可動オリフィス機構を設けることにより、パルス浸炭を実施でき、上記表面異常層のない、均一で表面炭素濃度過多による不具合がない煤の発生のない、コストを下げた真空浸炭装置を提供するものとなった。

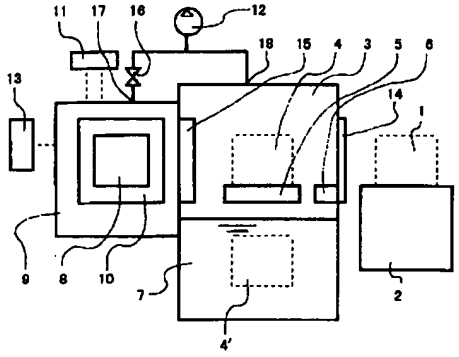
【図面の簡単な説明】

【図１】本発明の実施の形態を示す真空浸炭装置の全体概要図である。

【符号の説明】

３　冷却室　７　（焼き入れ用）油槽
１０　浸炭室　１１　供給する装置（ガス供給盤）
１２　真空排気装置　１６　調整バルブ（バルブ又は可動オリフィス機構）　１７　排気口

【図１】



フロントページの続き

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